Annex O

IPCC Reference Approach for Estimating CO_2 Emissions from Fossil Fuel Combustion

It is possible to estimate carbon emissions from fossil fuel consumption using alternative methodologies and different data sources than those described in Annex A. For example, the IPCC requires countries in addition to their "bottom-up" sectoral methodology to complete a "top-down" Reference Approach for estimating carbon dioxide emissions from fossil fuel combustion. Section 1.3 of the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reporting Instructions* states, "If a detailed, Sectoral Approach for energy has been used for the estimation of CO_2 from fuel combustion you are still asked to complete…the Reference Approach…for verification purposes" (IPCC/UNEP/OECD/IEA 1997). This reference method estimates fossil fuel consumption by adjusting national aggregate fuel production data for imports, exports, and stock changes rather than relying on end-user consumption surveys. The basic principle is that once carbon-based fuels are brought into a national economy, they are either saved in some way (e.g., stored in products, kept in fuel stocks, or left unoxidized in ash) or combusted, and therefore the carbon in them is oxidized and released into the atmosphere. Accounting for actual consumption of fuels at the sectoral or sub-national level is not required. The following discussion provides the detailed calculations for estimating CO_2 emissions from fossil fuel combustion from the United States using the IPCC-recommended Reference Approach.

Step 1: Collect and Assemble Data in Proper Format

To ensure the comparability of national inventories, the IPCC has recommended that countries report energy data using the International Energy Agency (IEA) reporting convention. National energy statistics were collected in physical units from several DOE/EIA documents in order to obtain the necessary data on production, imports, exports, and stock changes.[17] These data are presented in Table O-1.

The carbon content of fuel varies with the fuel's heat content. Therefore, for an accurate estimation of CO_2 emissions, fuel statistics should be provided on an energy content basis (e.g., BTU's or joules). Because detailed fuel production statistics are typically provided in physical units (as in Table O-1), they were converted to units of energy before carbon emissions were calculated. Fuel statistics were converted to their energy equivalents by using conversion factors provided by DOE/EIA. These factors and their data sources are displayed in Table O-2. The resulting fuel data are provided in Table O-3.

Step 2: Estimate Apparent Fuel Consumption

The next step of the IPCC Reference Approach is to estimate "apparent consumption" of fuels within the country. This requires a balance of primary fuels produced, plus imports, minus exports, and adjusting for stock changes. In this way, carbon enters an economy through energy production and imports (and decreases in fuel stocks) and is transferred out of the country through exports (and increases in fuel stocks). Thus, apparent consumption of primary fuels (including crude oil, natural gas liquids, anthracite, bituminous, subbituminous and lignite coal, and natural gas) can be calculated as follows:

Production + Imports - Exports - Stock Change

[17] For the United States, national aggregate energy statistics typically exclude data on the U.S. territories. As a result, national statistics were adjusted to include U.S. territories data. The territories include Puerto Rico, U.S. Virgin Islands, Guam, American Samoa, Wake Island, and U.S. Pacific Islands. Consumption data were used for the territories because they are thought to be more reliable than production, import, export, and stock change data.

Flows of secondary fuels (e.g., gasoline, residual fuel, coke) should be added to primary apparent consumption. The production of secondary fuels, however, should be ignored in the calculations of apparent consumption since the carbon contained in these fuels is already accounted for in the supply of primary fuels from which they were derived (e.g., the estimate for apparent consumption of crude oil already contains the carbon from which gasoline would be refined). Flows of secondary fuels should therefore be calculated as follows:

Imports - Exports - Stock Change

Note that this calculation can result in negative numbers for apparent consumption. This is a perfectly acceptable result since it merely indicates a net export or stock increase in the country of that fuel when domestic production is not considered.

The IPCC Reference Approach calls for estimating apparent fuel consumption before converting to a common energy unit. However, certain primary fuels in the United States (e.g., natural gas and steam coal) have separate conversion factors for production, imports, exports, and stock changes. In these cases, it is not appropriate to multiply apparent consumption by a single conversion factor since each of its components have different heat contents. Therefore, United States fuel statistics were converted to their heat equivalents before estimating apparent consumption. The energy value of bunker fuels used for international transport activities was subtracted before computing energy totals.[18] Results are provided in Table O-3.

Step 3: Estimate Carbon Emissions

Once apparent consumption is estimated, the remaining calculations are virtually identical to those for the "bottom-up" Sectoral Approach (see Annex A). That is:

- Potential carbon emissions were estimated using fuel-specific carbon coefficients (see Table O-4).[19]
- The carbon sequestered in non-energy uses of fossil fuels (e.g., plastics or asphalt) was then estimated and subtracted from the total amount of carbon (see Table O-5).
- Finally, to obtain actual carbon emissions, net carbon emissions were adjusted for any carbon that remained unoxidized as a result of incomplete combustion (e.g., carbon contained in ash or soot).[20]

Step 4: Convert to CO_2 Emissions

Because the IPCC reporting guidelines recommend that countries report greenhouse gas emissions on a full molecular weight basis, the final step in estimating CO_2 emissions from fossil fuel consumption was converting from units of carbon to units of CO_2. Actual carbon emissions were multiplied by the molecular-to-atomic weight ratio of CO_2 to carbon (44/12) to obtain total carbon dioxide emitted from fossil fuel combustion in teragrams (Tg). The results are contained in Table O-6.

[18] Bunker fuels refer to quantities of fuels used for international transportation. The IPCC methodology accounts for these fuels as part of the energy balance of the country in which they were delivered to end-users. Carbon dioxide emissions from the combustion of these fuels were estimated separately and were not included in U.S. national totals. This is done to ensure that all fuel is accounted for in the methodology and so that the IPCC is able to prepare global emission estimates.

[19] Carbon coefficients from EIA were used wherever possible. Because EIA did not provide coefficients for coal, the IPCC-recommended emission factors were used in the top-down calculations for these fuels. See notes in Table O-4 for more specific source information.

[20] For the portion of carbon that is unoxidized during coal combustion, the IPCC suggests a global average value of 2 percent. However, because combustion technologies in the United States are more efficient, the United States inventory uses 1 percent in its calculations for petroleum and coal and 0.5 percent for natural gas.

Comparison Between Sectoral and Reference Approaches

These two alternative approaches can both produce reliable estimates that are comparable within a few percent. The major difference between methodologies employed by each approach lies in the energy data used to derive carbon emissions (i.e., the actual reported consumption for the Sectoral Approach versus apparent consumption derived for the Reference Approach). In theory, both approaches should yield identical results. In practice, however, slight discrepancies occur. For the United States, these differences are discussed below.

Differences in Total Amount of Energy Consumed

Table O-7 and Table O-9[21] summarize the differences between the Reference and Sectoral approaches in estimating total energy consumption in the United States. Although theoretically the two methods should arrive at the same estimate for U.S. energy consumption, the Reference Approach provides an energy total that is 0.4 percent lower than the Sectoral Approach for 1997. The greatest difference lies in the higher estimate of petroleum consumption with the Sectoral Approach (1.0 percent).

There are several potential sources for the discrepancies in consumption estimates:

- *Product Definitions*. The fuel categories in the Reference Approach are different from those used in the Sectoral Approach, particularly for petroleum. For example, the Reference Approach estimates apparent consumption for crude oil. Crude oil is not typically consumed directly, but refined into other products. As a result, the United States does not focus on estimating the energy content of crude oil, but rather estimating the energy content of the various products resulting from crude oil refining. The United States does not believe that estimating apparent consumption for crude oil, and the resulting energy content of the crude oil, is the most reliable method for the United States to estimate its energy consumption. Other differences in product definitions include using sector-specific coal statistics in the Sectoral Approach (i.e., residential, commercial, industrial coking, industrial other, and transportation coal), while the Reference Approach characterizes coal by rank (i.e. anthracite, bituminous, etc.). Also, the liquefied petroleum gas (LPG) statistics used in the bottom-up calculations are actually a composite category composed of natural gas liquids (NGL) and LPG.
- Heat Equivalents. It can be difficult to obtain heat equivalents for certain fuel types, particularly for categories such as "crude oil" where the key statistics are derived from thousands of producers in the United States and abroad. For heat equivalents by coal rank, it was necessary to refer back to EIA's *State Energy Data Report 1992* (1994) because this information is no longer published.
- *Possible inconsistencies in U.S. Energy Data*. The United States has not focused its energy data collection efforts on obtaining the type of aggregated information used in the Reference Approach. Rather, the United States believes that its emphasis on collection of detailed energy consumption data is a more accurate methodology for the United States to obtain reliable energy data. Therefore, top-down statistics used in the Reference Approach may not be as accurately collected as bottom-up statistics applied to the Sectoral Approach.
- *Balancing Item.* The Reference Approach uses *apparent* consumption estimates while the Sectoral Approach uses *reported* consumption estimates. While these numbers should be equal, there always seems to be a slight difference that is often accounted for in energy statistics as a "balancing item."

Differences in Estimated CO_2 Emissions

Given these differences in energy consumption data, the next step for each methodology involved estimating emissions of CO_2. Table O-8 summarizes the differences between the two methods in estimated carbon emissions for 1997. Although complete data and calculations are not presented, comparison tables are also presented for 1996 emissions in Table O-10.

As shown previously, the Sectoral Approach resulted in a 0.4 percent higher estimate of energy consumption in the United States than the Reference Approach, but the resulting emissions estimate for the Reference Approach is 0.8 percent higher. While both methods' estimates of natural gas emissions are almost exactly the same, coal and

[21] Although complete energy consumption data and calculations are not presented, comparison tables are also presented for 1996.

petroleum emission estimates from the Reference Approach are higher than the Sectoral Approach. Potential reasons for these patterns may include:

- *Product Definitions.* Coal data is aggregated differently in each methodology, as noted above, with United States coal data typically collected in the format used for the Sectoral Approach. This results in more accurate estimates than in the Reference Approach. Also, the Reference Approach relies on a "crude oil" category for determining petroleum-related emissions. Given the many sources of crude oil in the United States, it is not an easy matter to track potential differences in carbon content between different sources of crude, particularly since information on the carbon content of crude oil is not regularly collected.
- *Carbon Coefficients.* The Reference Approach relies on several default carbon coefficients provided by IPCC (IPCC/UNEP/OECD/IEA 1997), while the Sectoral Approach uses category-specific coefficients that are likely to be more accurate. Also, as noted above, the carbon coefficient for crude oil is not an easy value to obtain given the many sources and grades of crude oil consumed in the United States.

Although the two approaches produce similar results, the United States believes that the "bottom-up" Sectoral Approach provides a more accurate assessment of CO_2 emissions at the fuel level. This improvement in accuracy is largely a result of the data collection techniques used in the United States, where there has been more emphasis on obtaining the detailed products-based information used in the Sectoral Approach than obtaining the aggregated energy flow data used in the Reference Approach. The United States believes that it is valuable to understand both methods.

References

EIA (1998a) *Annual Energy Review 1997*, DOE/EIA- 0384(97)-annual, Energy Information Administration, U.S. Department of Energy, Washington, DC.

EIA (1998b) *Coal Industry Annual – 1997*, DOE/EIA 0584(97)-annual, Energy Information Administration, U.S. Department of Energy, Washington, DC.

EIA (1998c) *Emissions of Greenhouse Gases in the United States 1997*, DOE/EIA 0573(97)-annual, Energy Information Administration, U.S. Department of Energy, Washington, DC.

EIA (1998d) *Monthly Energy Review*, DOE/EIA 0035(98)-monthly, Energy Information Administration, U.S. Department of Energy, Washington, DC. November.

EIA (1998e) *Petroleum Supply Annual – 1997*, DOE/EIA 0340(97)-annual, Energy Information Administration, U.S. Department of Energy, Washington, DC, Volume I.

EIA (1994*) State Energy Data Report 1992*, DOE/EIA 0214(92)-annual, Energy Information Administration, U.S. Department of Energy, Washington, DC.

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, Paris: Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency.

Table O-1: 1997 U.S. Energy Statistics (physical units)

Fuel Category (Units)	Fuel Type	Production	Imports	Exports	Stock Change	Bunkers	U.S. Territories
Solid Fuels (1000 Short Tons)	Anthracite Coal	4,692	[1]	[1]	[1]		
	Bituminous Coal	653,828	[1]	[1]	[1]		
	Sub-bituminous Coal	345,071	[1]	[1]	[1]		
	Lignite	86,341	[1]	[1]	[1]		
	Coke		1,565	832	(29)		
	Unspecified Coal		7,487	83,545	(10,817)		480
Gas Fuels (Million Cubic Feet)	Natural Gas	19,152,427	2,972,368	157,463	(26,906)		
Liquid Fuels (Thousand Barrels)	Crude Oil	2,354,831	3,002,299	39,308	18,450		
	Nat Gas Liquids and LRGs	663,266	74,831	20,882	2,617		2,791
	Other Liquids	78,471	224,060	9,265	5,576		
	Motor Gasoline		112,837	49,878	9,367		27,547
	Aviation Gasoline		41	-	(575)		
	Kerosene		570	138	273		12,949
	Jet Fuel		33,109	12,763	4,178	128,123	
	Distillate Fuel		83,102	55,507	11,698	13,637	19,371
	Residual Fuel		70,829	43,782	(5,458)	83,221	27,912
	Naptha for petrochemical feedstocks		18,681	-	35		
	Petroleum Coke		386	111,615			
	Other Oil for petrochemical feedstocks		69,086	-	772		
	Special Napthas		2,709	7,849	281		
	Lubricants		4,026	11,275	215		-
	Waxes		441	993	(80)		
	Asphalt/Road Oil		11,862	2,879	1,619		
	Still Gas		-	-	-		
	Misc. Products		101	125	618		20,005

[1] Included in Unspecified Coal

Data Sources: Solid Fuels - EIA Coal Industry Annual 1997; Gas Fuels - EIA Annual Energy Review 1997; Liquid Fuels - EIA Petroleum Supply Annual 1997

Table O-2: Conversion Factors to Energy Units (heat equivalents)

Fuel Category (Units)	Fuel Type	Production	Imports	Exports	Stock Change	Bunkers	U.S. Territories
Solid Fuels (Million Btu/Short Ton)	Anthracite Coal	22.573					
	Bituminous Coal	23.89					
	Sub-bituminous Coal	17.14					
	Lignite	12.866					
	Coke		24.8	24.8	24.8		
	Unspecified		25.000	26.174	21.287		21.287
Natural Gas (BTU/Cubic Foot)		1,027	1,022	1,011	1,027		
Liquid Fuels (Million Btu/Barrel)	Crude Oil	5.800	5.935	5.800	5.800	5.800	5.800
	Nat Gas Liquids and LRGs	3.777	3.777	3.777	3.777	3.777	3.777
	Other Liquids	5.825	5.825	5.825	5.825	5.825	5.825
	Motor Gasoline		5.253	5.253	5.253	5.253	5.253
	Aviation Gasoline		5.048	5.048	5.048	5.048	5.048
	Kerosene		5.67	5.67	5.67	5.67	5.67
	Jet Fuel		5.67	5.67	5.67	5.67	5.67
	Distillate Fuel		5.825	5.825	5.825	5.825	5.825
	Residual Oil		6.287	6.287	6.287	6.287	6.287
	Naptha for petrochemical feedstocks		5.248	5.248	5.248	5.248	5.248
	Petroleum Coke		6.024	6.024	6.024	6.024	6.024
	Other Oil for petrochemical feedstocks		5.825	5.825	5.825	5.825	5.825
	Special Napthas		5.248	5.248	5.248	5.248	5.248
	Lubricants		6.065	6.065	6.065	6.065	6.065
	Waxes		5.537	5.537	5.537	5.537	5.537
	Asphalt/Road Oil		6.636	6.636	6.636	6.636	6.636
	Still Gas		6.000	6.000	6.000	6.000	6.000
	Misc. Products		5.796	5.796	5.796	5.796	5.796

Data Sources: Coal and lignite production - EIA State Energy Data Report 1992; Coke - EIA Monthly Energy Review, November 1998; Unspecified Solid Fuels - EIA Monthly Energy Review, November 1998; Natural Gas - EIA Monthly Energy Review, November 1998; Crude Oil - EIA Monthly Energy Review, November 1998; Natural Gas Liquids and LRGs - EIA Petroleum Supply Annual 1997; all other Liquid Fuels - EIA Monthly Energy Review, November 1998

Table O-3: 1997 Apparent Consumption of Fossil Fuels (TBtu)

Fuel Category	Fuel Type	Production	Imports	Exports	Stock Change	Bunkers	U.S. Territories	Apparent Consumption
Solid Fuels	Anthracite Coal	105.9					-	**105.9**
	Bituminous Coal	15,620.0					-	**15,620.0**
	Sub-bituminous Coal	5,914.5					-	**5,914.5**
	Lignite	1,110.9					-	**1,110.9**
	Coke	-	38.8	20.6	(0.7)		-	**18.9**
	Unspecified	-	187.2	2,186.7	(230.3)		10.2	**(1,759.1)**
Gas Fuels	Natural Gas	19,669.5	3,037.8	159.2	(27.6)		-	**22,575.7**
Liquid Fuels	Crude Oil	13,658.0	17,818.6	228.0	107.0	-	-	**31,141.7**
	Nat Gas Liquids and LRGs	2,505.2	282.6	78.9	9.9	-	10.5	**2,709.6**
	Other Liquids	457.1	1,305.1	54.0	32.5	-	-	**1,675.8**
	Motor Gasoline	-	592.7	262.0	49.2	-	144.7	**426.2**
	Aviation Gasoline	-	0.2	-	(2.9)	-	-	**3.1**
	Kerosene	-	3.2	0.8	1.5	-	73.4	**74.3**
	Jet Fuel	-	187.7	72.4	23.7	726.5	-	**(634.8)**
	Distillate Fuel	-	484.1	323.3	68.1	79.4	112.8	**126.0**
	Residual Oil	-	445.3	275.3	(34.3)	523.2	175.5	**(143.4)**
	Naptha for petrochemical feedstocks	-	98.0	-	0.2	-	-	**97.9**
	Petroleum Coke	-	2.3	672.4	16.6	-	-	**(686.7)**
	Other Oil for petrochemical feedstocks	-	402.4	-	4.5	-	-	**397.9**
	Special Napthas	-	14.2	41.2	1.5	-	-	**(28.4)**
	Lubricants	-	24.4	68.4	1.3	-	-	**(45.3)**
	Waxes	-	2.4	5.5	(0.4)	-	-	**(2.6)**
	Asphalt/Road Oil	-	78.7	19.1	10.7	-	-	**48.9**
	Still Gas	-	-	-	-	-	-	**0.0**
	Misc. Products	-	0.6	0.7	3.6	-	115.9	**112.2**
Total		59,041.1	25,006.6	4,468.4	34.1	988.2	643.2	**78,859.3**

Note: Totals may not sum due to independent rounding.

Table O-4: 1997 Potential Carbon Emissions

Fuel Category	Fuel Type	Apparent Consumption (QBtu)	Carbon Coefficients (MMTCE/QBtu)	Potential Carbon Emissions (MMTCE)
Solid Fuels	Anthracite Coal	0.106	26.86	**2.8**
	Bituminous Coal	15.620	25.86	**403.9**
	Sub-bituminous Coal	5.915	26.26	**155.3**
	Lignite	1.111	27.66	**30.7**
	Coke	0.019	25.56	**0.5**
	Unspecified	(1.759)	25.74	**(45.3)**
Gas Fuels	Natural Gas	22.576	14.47	**326.7**
Liquid Fuels	Crude Oil	31.142	20.23	**630.0**
	Nat Gas Liquids and LRGs	2.710	16.99	**46.0**
	Other Liquids	1.676	20.23	**33.9**
	Motor Gasoline	0.426	19.38	**8.3**
	Aviation Gasoline	0.003	18.87	**0.1**
	Kerosene	0.074	19.72	**1.5**
	Jet Fuel	(0.635)	19.33	**(12.3)**
	Distillate Fuel	0.126	19.95	**2.5**
	Residual Oil	(0.143)	21.49	**(3.1)**
	Naptha for petrochemical feedstocks	0.098	18.14	**1.8**
	Petroleum Coke	(0.687)	27.85	**(19.1)**
	Other Oil for petrochemical feedstocks	0.398	19.95	**7.9**
	Special Napthas	(0.028)	19.86	**(0.6)**
	Lubricants	(0.045)	20.24	**(0.9)**
	Waxes	(0.003)	19.81	**(0.1)**
	Asphalt/Road Oil	0.049	20.62	**1.0**
	Still Gas	0.000	17.51	**0.0**
	Misc. Products	0.112	19.81	**2.2**
Total				**1,573.9**

Data Sources: Coal and Lignite - *Revised 1996 IPCC Guidelines Reference Manual*, Table 1-1; Coke - EIA *Monthly Energy Review*, November 1998 Table C1; Unspecified Solid Fuels - EIA *Monthly Energy Review*, November 1998 Table C1 (U.S. Average); Natural Gas and Liquid Fuels - EIA *Emissions of Greenhouse Gases in the United States 1997.*
Note: Totals may not sum due to independent rounding.

Table O-5: 1997 Non-Energy Carbon Stored in Products

Fuel Type	Consumption for Non-Energy Use (TBtu)	Carbon Coefficients (MMTCE/QBtu)	Carbon Content (MMTCE)	Fraction Sequestered	Carbon Sequestered (MMTCE)
Coal	27.7	25.55	0.7	0.75	**0.5**
Natural Gas	391.4	14.47	5.7	1.00	**5.7**
Asphalt & Road Oil	1223.6	20.62	25.2	1.00	**25.2**
LPG	1651.3	16.86	27.8	0.80	**22.3**
Lubricants	354.4	20.24	7.2	0.50	**3.6**
Pentanes Plus	295.4	18.24	5.4	0.80	**4.3**
Petrochemical Feedstocks	[1]	[1]	[1]	[1]	**15.9**
Petroleum Coke	179.0	27.85	5.0	0.50	**2.5**
Special Naptha	72.3	19.86	1.4	0	**0.0**
Waxes/Misc.	[1]	[1]	[1]	[1]	**3.4**
Misc. U.S. Territories Petroleum	[1]	[1]	[1]	[1]	**0.2**
Total					**83.6**

[1] Values for Misc. U.S. Territories Petroleum, Petrochemical Feedstocks and Waxes/Misc. are not shown because these categories are aggregates of numerous smaller components.
Note: Totals may not sum due to independent rounding.

Table O-6: Reference Approach CO_2 Emissions from Fossil Fuel Consumption (MMTCE unless otherwise noted)

Fuel Category	Potential Carbon Emissions	Carbon Sequestered	Net Carbon Emissions	Fraction Oxidized (percent)	CO_2 Emissions (MMTCE)	CO_2 Emissions (Tg)
Coal	548.0	0.5	547.5	99.0%	**542.0**	**1,987.4**
Petroleum	699.2	77.4	621.7	99.0%	**615.5**	**2,256.9**
Natural Gas	326.7	5.7	321.0	99.5%	**319.4**	**1,171.1**
Total	1,573.9	83.6	1,490.2	-	**1,476.9**	**5,415.4**

Note: Totals may not sum due to independent rounding.

Table O-7: 1997 Energy Consumption in the United States: Sectoral vs. Reference Approaches (TBtu)

Approach	Coal	Natural Gas	Petroleum	Total
Sectoral[a]	20,931.8	22,575.3	35,632.8	79,140.0
Reference (Apparent)[a]	21,011.1	22,575.7	35,272.4	78,859.3
Difference	**0.4%**	**0.0%**	**-1.0%**	**-0.4%**

[a] Includes U.S. territories
Note: Totals may not sum due to independent rounding.

Table O-8: 1997 CO_2 Emissions from Fossil Fuel Combustion by Estimating Approach (MMTCE)

Approach	Coal	Natural Gas	Petroleum	Total
Sectoral[a]	533.3	319.4	613.3	1,465.9
Reference[a]	542.0	319.4	615.5	1,476.9
Difference	**1.6%**	**0.0%**	**0.4%**	**0.8%**

[a] Includes U.S. territories
Note: Totals may not sum due to independent rounding.

Table O-9: 1996 Energy Consumption in the United States: Sectoral vs. Reference Approaches (TBtu)

Approach	Coal	Natural Gas	Petroleum	Total
Sectoral[a]	20,459	22,552	35,170	78,181
Reference (Apparent)[a]	20,334	22,547	34,642	77,523
Difference	**-0.6%**	**0.0%**	**-1.5%**	**-0.8%**

[a] Includes U.S. territories
Note: Totals may not sum due to independent rounding.

Table O-10: 1996 CO_2 Emissions from Fossil Fuel Combustion by Estimating Approach (MMTCE)

Approach	Coal	Natural Gas	Petroleum	Total
Sectoral[a]	521.1	319.3	607.2	1,447.7
Reference[a]	524.7	319.3	605.6	1,449.5
Difference	**0.7%**	**0.0%**	**-0.3%**	**0.1%**

[a] Includes U.S. territories
Note: Totals may not sum due to independent rounding.